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## NOTICES FROM THE LICK OBSERVATORY.\*

PREPARED BY MEMBERS OF THE STAFF.

### FURTHER OBSERVATIONS OF THE NEBULA ABOUT *NOVA PERSEI*.

Since the photograph of November 7-8th, five other negatives have been secured with the Crossley reflector, as follows:— November 12-13th, December 4th, December 8th and 11th, January 2-3d and January 10-11th. With the exception of that of December 4th, all have had exposures of ten hours. These later photographs have been obtained on quicker plates, and with the longer exposures, much more detail is shown than on the first.

These negatives show two distinct regions of nebulosity to exist about the *Nova*. The region about the star within a radius of 7' is filled with nebulosity showing much detail. It is in this region where the condensations are situated which were first observed to be in rapid motion. Outside of this circular region of 15' diameter is a ring of very much fainter nebulosity, having an extreme diameter of 30'. This nebulosity is so faint, in fact, that, with the exception of a few of the brighter wisps, it is not visible until intensified by successive copyings on slow plates. This method of bringing out faint contrasts is one well known to experienced photographers and has long been in use at this Observatory.

The motions which were observed in some of the brighter condensations are shown by the later photographs to continue. These motions are not radial, although the entire circle of nebula is expanding. Some of the observed motions are clockwise, while others appear to be moving in the opposite direction.

With the exception of two groups of filaments in the faint outer ring of nebulosity, there is not sufficient structure there for a satisfactory determination of motions. Of the two masses mentioned, one shows a clockwise motion and the other a counter-clockwise motion of about 3' in the interval of a month between the December and January observations. The larger proportion

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of motion is tangential, the radial component amounting to nearly  $1'$ . Neither of these two groups of nebulosities was visible on the photograph of November 7-8th. One of them shows very faintly on the negative of November 12-13th, the other on a negative with only  $5\frac{1}{2}$  hours' exposure on December 4th. The later negatives all show both groups. Some exceedingly fine structural detail is also shown on the later negatives in the extreme outer portion of this outer ring, to the west of *Nova*. This detail is composed of the finest threadlike filaments, and in this also can be traced a general outward movement.

In examining the earlier short-exposure negatives of the *Nova* for another purpose, I found one, taken on March 29th with an exposure of ten minutes, which shows a complete ring of faint nebulosity about the *Nova*. These photographs were obtained by Messrs. H. K. PALMER and C. G. DALL while the writer was absent on the Eclipse Expedition to Sumatra.

This photograph carries back our knowledge of the nebula nearly five months. The earliest observations previously known were by Professor MAX WOLF, on August 23d, and Mr. RITCHEY, of the Yerkes Observatory, on September 20th.

The ring of nebulosity shown on the negative of March 29th is not perfectly circular, but is flattened on the southwest side. The longer axis of the oval is in the direction southeast-northwest, and is about  $5'$  in length. The ring is approximately  $20''$  in width in the best-defined portions. The nebulosity at the ends of this oval is much more diffuse and broadened and resembles somewhat the Annular Nebula in *Lyra*. Inside this ring and very close around the star is an elliptical ring of much fainter nebulosity whose major axis is in position-angle  $60^\circ$ . The *Nova* occupies the southwest focus of this ellipse, whose major axis is  $2\frac{1}{2}'$  in length and its minor axis  $2'$ .

A narrow circular arc of nebulosity extends from position-angle  $0^\circ$  to  $90^\circ$  at a distance of  $5'$  from *Nova*, which occupies the center of curvature.

Besides the features described, there is a series of faint envelopes to the south of the star, at a distance of  $3'$ , which has an arrow-shaped form pointing to the east. There are also some faint masses of nebulosity to be seen inside the larger ring. As the later observations showed the outer ring of nebulosity to be expanding at about the rate which would have carried the ring of March 29th to its present position, the assumption of probable

identity was made and the velocity of recession radially from the star determined. This was possible from two well-defined masses on the outer rim of the large exterior nebulosity, using the interval March 29, 1901, to January 2-3, 1902. One of these masses was southwest of *Nova*, the other north. The mass to the southwest gave a velocity of  $3''.00$  per day; the mass to the north gave a velocity of  $2''.62$  per day. These velocities carry their respective nebulosities (both rings) back to the *Nova* on February 17th and 16th. Each pair of results agrees within a small fraction of a day, which must be considered largely accidental owing to the uncertainties of measuring such objects. Many of the condensations are growing fainter, owing, probably, to the general expansion. Condensation A was very compact when first observed on November 7-8th. It has now separated into three envelopes, the whole being much fainter. Several new masses have appeared in its vicinity. Condensation D seems to have remained unchanged either in intensity or form, since November 7-8th.

We may summarize briefly the results of a comparison of all our negatives, as follows:—

Great changes are still going on in the nebulosity about the *Nova*. Some masses appear to be growing brighter, while others are growing fainter.

The nebulosity is found chiefly in two regions. The brighter is situated in a circular area  $15'$  in diameter, in which *Nova* occupies the center. Around this region is a ring of much fainter nebulosity  $30'$  in diameter. Both of these regions are expanding rapidly in all directions. Many portions of the nebula are in rapid motion. Several of the condensations appear to have a spiral motion, some clockwise, others the reverse. No entirely radial motion has been observed. The nebulosity now visible appears to have been expelled from the region of the star about February 16th or 17th (neglecting light transmission) in the general form of rings or shells.

If this nebulosity is moving in all directions at its present rate of speed, and should continue at this rate, some of it should reach the solar system in 250 years or less.

Messrs. H. K. PALMER and JOEL STEBBINS, Fellows in Astronomy, have assisted in taking the later photographs with the Crossley reflector.

C. D. PERRINE.

MT. HAMILTON, CALIFORNIA, 1902, January 15.